PROPOSAL SIGNATURE FORM

THIS FORM MUST BE SIGNED BY THE PROPOSED PRINCIPAL INVESTIGATOR AND SUBMITTED ALONG WITH THE PROPOSAL. If the proposal has more than one investigator, this form must be signed by at least one of the investigators, and that investigator will ensure that Trustee Council requirements are followed. Proposals will not be reviewed until this signed form is received by the Trustee Council Office.

By submission of this proposal, I agree to abide by the Trustee Council's data policy (Trustee Council Data Policy*, adopted March 17, 2008) and reporting requirements (Procedures for the Preparation and Distribution of Reports**, adopted June 27, 2007).

PROJECT TITLE:	**Re-Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound – Submitted Under the BAA AB133F-09-RP-0059**
Printed Name of PI	**Dennis C. Lees**
Email:	dennislees@cox.net
Mailing Address	**1075 Urania Ave.**
City, State, Zip	**Leucadia, CA 92024**
Phone:	**760-635-7998**
Signature of PI:	Dennis C. Lees Date: **30 June 2009**
Printed Name of PI	
Email:	
Mailing Address	
City, State, Zip	
Phone:	
Signature of PI:	Date:
Printed Name of PI	
Email:	
Mailing Address	
City, State, Zip	
Phone:	
Signature of PI:	Date:

* www.evostc.state.ak.us/Policies/data.cfm
** www.evostc.state.ak.us/Policies/reporting.cfm

1

FY10 INVITATION
PROPOSAL SUMMARY PAGE

Project Title: Re-Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound – Submitted Under the BAA AB133F-09-RP-0059

Project Period: 1 October 2009 (FY10) – September 30, 2012 (FY12)

Primary Investigator(s): Dennis C. Lees, Littoral Ecological & Environmental Services

Study Location: Prince William Sound, from Eleanor Island south to Latouche Island

Abstract:

Studies from 1989 through 1997 suggested that bivalve assemblages on beaches in Prince William Sound (PWS) treated with high-pressure hot-water washing remain damaged. An EVOS-funded study in 2002 confirmed this hypothesis; hardshell clams were only one-third as abundant at Treated sites as at Unwashed sites. Considering the importance of hardshell clams to sea otters, other nearshore predators, and humans, this finding is important.

Using information from 1989, we constructed a preliminary recovery trajectory. This model predicts that clam assemblages at Treated sites in PWS will require more than five decades to recover. Subsequently, a less extensive study of clam assemblages in PWS and research in other areas suggest that hardshell clams may be experiencing recruitment failures throughout the Pacific Northwest. By re-evaluating the status of clam populations at 40 sites sampled in 2002, this project will: 1) improve the accuracy of the recovery trajectory for PWS clam assemblages by adding a third point for abundance at Treated sites; and 2) provide insights into the generality of the hypothesis that hardshell clam recruitment is failing throughout the Pacific Northwest.

Estimated Budget:

EVOS Funding Requested *(must include 9% GA)*

FY10	FY11	FY12	FY13	Total
$136.6	95.4	32.6	$0	261.6

Non-EVOS Funds to be used:

FY10	FY11	FY12	FY13	Total
$0	$0	$0	$0	$0

(NOT TO EXCEED ONE PAGE)

PROJECT PLAN

I. NEED FOR THE PROJECT

Based on studies from 1989 through 1996, we became concerned about the implications of differences in abundance of hardshell clams that we observed between oiled-and-washed (treated) and oiled-but-unwashed (Unwashed) sites in western Prince William Sound (PWS; Houghton *et al.* 1997). Our concern was that the clam assemblages at the Treated sites were substantially impoverished relative to those at the Unwashed sites. This condition had considerable relevance on the restoration of injured resources and services. We postulated these differences were due primarily to differences in inorganic and organic sediment concentrations rather than hydrocarbons in the sediments. In a 2002 study funded by the Exxon Valdez Oil Spill Trustee Council, we examined the hypotheses that: 1) hardshell clams were less abundant at Treated sites than at Unwashed sites; and 2) these differences were related to differences in concentrations of inorganic and organic constituents in the sediments. We found that, indeed, both adult and juvenile hardshell clams were only one-third as abundant at the Treated sites, but that concentrations of inorganic and organic constituents were not implicated in these differences. Instead, we concluded that disruption of a previously unrecognized phenomenon, organization of the coarse surficial fraction of the sediments (armoring), was the major factor resulting in lagging recovery of the hardshell clam assemblages. Based on this hypothesis, we predicted that recovery of the clam assemblage could take between 50 and 100 years (Lees and Driskell 2007).

A. Statement of Problem

The primary reason we are proposing this study is to re-assess conditions in the hardshell clam assemblages at the forty sites that we surveyed in 2002 (Lees and Driskell 2007). Analysis of data provided by this study will provide a third point on the recovery trajectory, thereby refining the estimate of the time required for these valuable resources to recovery from beach washing. This consideration is important from the viewpoint of evaluating the past injury to the resources of PWS, but also as a consideration in future deliberations on shoreline response and habitat management in the event of another oil spill or other catastrophic event in PWS or elsewhere in the world.

A secondary reason for this study is that it will provide comparative data to allow evaluation of the report by Shigenaka *et al.* (2008) that recruitment of hardshell clam populations, especially littleneck clams (*Leukoma* [=*Protothaca*] *staminea*), appears to be failing in PWS and elsewhere in the Pacific Northwest, based on their survey during the summer of 2007.

B. Relevance to 1994 Restoration Plan Goals and Scientific Priorities

The 1994 Restoration Plan defines the terms “Restore” and “Restoration” to mean “any action, in addition to response and clean-up activities required or authorized by state or federal law, that endeavors to restore to their prespill condition any natural resource injured, lost, or destroyed as a result of the Oil Spill and the services provided by the resource, or that replaces or substitutes for the injured, lost or destroyed resource and affected services.”

In the Policies section of that document, the plan specifies that: "Restoration will take an ecosystem approach to better understand what factors control the populations of injured resources". The plan further indicates that: "Restoration will focus upon injured resources and services and will emphasize resources and services that have not recovered. ... Priority will be given to restoring injured resources and services which have economic, cultural and subsistence value to people living in the oil spill area, as long as this is consistent with other policies." Other policy specifications specify that:

- Restoration activities will occur primarily within the spill area.
- Projects designed to restore or enhance an injured service … must have a sufficient relationship to an injured resource.
- Restoration should be guided and reevaluated as information is obtained from damage assessment studies and restoration actions.
- Priority shall be given to strategies that involve multi-disciplinary, interagency, or collaborative partnerships.

The proposed program complies nicely with these policies. It takes an ecosystem approach. It is based on an earlier study that confirmed that hardshell clams had not recovered from the severe injury caused by beach washing activities during the cleanup. The populations have cultural and subsistence value to the people living in the spill area, as well as considerable value to nearshore vertebrate predators such as sea otters. The study will take place in the spill area, is directly related to the injured resource, and will provide guidance for reevaluating restoration status of clam assemblages. Because of the importance of sediment characteristics to the clams and their recovery, this is definitely a multi-disciplinary study.

The proposed study fits well in the Monitoring and Research program because it provides important information to help guide restoration activities. It will provide an update on the status and condition of clam resources and services and more detail on what factors may be constraining recovery. It fulfills a need for monitoring the recovery status of an injured resource. The proposed program will track "the rate and degree of recovery of the resource [clams] and services injured by the spill". It complies with the specification in the plan that: "Monitoring is needed periodically at least until a resource recovers." Furthermore, the study will provide helpful "information about key relationships in the ecosystem that are important for one or more injured resource or service" by clarifying habitat requirements and the relationships between the long-lived clams and sediment conditions and organization. As encouraged in the plan, this study includes "… research to determine why an injured resource is not recovering, thus contributing to more effective restoration and management".

The proposed program bears relevance to one primary element in the 1994 Restoration Plan Goals and Scientific Priorities, but also provides information useful for other elements. The most relevant resource element is Clams. That element documented that "littleneck clams and butter clams on sheltered beaches were killed by oiling and cleanup activities. In addition,

growth appeared to be reduced by oil… . Our 2002 study showed clearly that the injury remained serious 13 years after the spill and we predicted that recovery could take more than 50 years.

The element specifies that: "Clams will have recovered when populations and productivity have returned to levels that would have prevailed in the absence of the oil spill (prespill data or unoiled control sites)." Furthermore, the element noted: "Clams are important for subsistence use and also serve as prey for sea otters and sea ducks …". Finally, the element urged that the Trustee Council should: "Monitor the density and size of clams in select clam beds." This program is designed to measure density, size- and age-structure of hardshell clams at 40 sites that were surveyed for clams 7 years ago, in 2002. This qualifies as monitoring and also will provide a much-needed third point to the recovery trajectory for injured clam resources, thus imparting greater accuracy to that curve. It is also important to point out that this program is far more intensive than other clam studies conducted in PWS. Moreover, because it is based on random site selection and examines large as well as small size classes of hardshell clams, findings from this study have far greater power and can be extrapolated to the larger area affected by the spill.

II. PROJECT DESIGN

A. Objectives

The purposes of this program are to determine if the impoverished condition of intertidal bivalve assemblages initially observed in oiled and treated areas during the 1990-97 NOAA studies (Houghton *et al.* 1997) and subsequently confirmed during our 2002 EVOS study (Lees and Driskell 2007) persists at Treated sites throughout the western sound and to expand our understanding of the role of disrupted "armoring" of the sediments on delayed recovery of the clam assemblages. The major objectives for the proposed study are to:

- Evaluate whether the depressed condition of bivalve assemblages at Treated sites observed in our earlier studies continues to be general at Treated sites throughout western Prince William Sound;
- Attempt to develop metrics for "armoring" and measure differences in the organization of larger clasts on coarse-grained beaches and between Treated and Unwashed beaches;
- Evaluate if the hypothesized role of "armoring" continues to be valid;
- Re-assess the validity of the hypothesis that differences in three sediment characteristics (% silt/clay, TOC, and TKN) between Treated and Unwashed sites do not play in the apparent depression of bivalve assemblages in treated sediments; and
- Add a third point to the recovery trajectory, thus increasing the accuracy of recovery predictions;
- Assess the accuracy of the hypothesis that hardshell clams are suffering recruitment failure in Prince William Sound (Shigenaka *et al.* 2008) based on a paired comparison of hardshell clam abundance at sites sampled in 2002 and in this study.

An additional objective of this program will be to apprise local communities in Prince William Sound of the results of our previous studies on the bivalve assemblages in the sound and the objectives of this study. Clams are an important subsistence resource and the area in which these studies have taken place is particularly important to the native villages of Chenega and Tatitlek. To achieve this objective, we will contact village leaders of Cordova, Tatitlek, and Chenega to arrange to make presentations to their community members during our field efforts in 2010. These efforts are included in our budget for FY2010. The presentation, requiring about 1 hour, will summarize the results of our research and allow the attendees to ask questions and make suggestions on possible directions for future research. Prior to those presentations, we will contact researchers that have evaluated hydrocarbon body burdens in clams in Prince William Sound, especially in clam beds near the native villages, so that we may address questions on this concern.

The major hypotheses that will be tested to compare patterns in bivalve assemblages between oiled and Treated and Unwashed sites in western PWS are listed below:

1. Bivalve Assemblages

a. H_o = Numerical characteristics of the bivalve assemblage (numbers of taxa and individuals) are similar at Treated and Unwashed sites.

H_a = Numerical characteristics of the bivalve assemblage exhibit lower values at wash sites that at Unwashed sites.

b. H_o =Species composition of the bivalve fauna is similar at Treated and Unwashed sites.

H_a = Species composition of the bivalve fauna is more complex and productive at Unwashed sites than at Treated sites.

c. H_o =Abundance of hardshell clams is similar at Treated and Unwashed sites.

H_a = Abundance of hardshell clams is greater at Unwashed sites than at Treated sites.

d. H_o = Large hardshell clam abundance is statistically similar at Treated and Unwashed sites across an exposure gradient.

H_a = Large hardshell clam abundance is dissimilar at Treated and Unwashed sites across an exposure gradient. Large hardshell clams become more abundant with increasing exposure at Unwashed sites while showing no response at Treated sites.

e. H_o = Small hardshell clam abundance is statistically similar at Treated and Unwashed sites across an exposure gradient.

H_a = Small hardshell clam abundance is dissimilar at Treated and Unwashed sites across an exposure gradient. Abundance of small hardshell clams decreases with increasing exposure at Treated sites but shows no response to increasing exposure at Unwashed sites.

2. Physico-Chemical Characteristics

f. H_o = Sediment characteristics are statistically similar at Treated and Unwashed sites. Percent silt/clay, Total Organic Carbon, Total Kjeldahl Nitrogen, and C: N ratios are similar at Treated and Unwashed sites.

H_a = Sediment characteristics are dissimilar at Treated and Unwashed sites. Percent silt/clay, Total Organic Carbon, and Total Kjeldahl Nitrogen are lower at Treated than at Unwashed sites, and C:N ratios are higher at Treated than at Unwashed sites.

g. H_o = Sediment characteristics are statistically similar at Treated and Unwashed sites across an exposure gradient. Percent silt/clay, Total Organic Carbon, and Total Kjeldahl Nitrogen ratios are similar across an exposure gradient at Treated and Unwashed sites.

H_a = Sediment characteristics are dissimilar at Treated and Unwashed sites across an exposure gradient. Percent silt/clay, Total Organic Carbon, and Total Kjeldahl Nitrogen become lower with increasing exposure at Treated sites while showing no effect at Unwashed sites.

h. H_o = Metrics describing organization of coarse-grain sediments at Treated and Unwashed sites are statistically similar.

H_a = Metrics describing organization of coarse-grain sediments at Treated and Unwashed sites indicate that sediments at Unwashed sites are more highly organized than at Treated sites.

B. Procedural and Scientific Methods

1. Site Selection

Because major purposes of this study are to monitor recovery and compare bivalve abundance in 2002 and 2010, we will sample nearly all the same sites during this survey that we sampled during the 2002 survey. Site selection for the 2002 study was random except for the NOAA sites that were resampled to assess consistency with the findings of the 1990 - 1996 NOAA studies. For this proposal, we are proposing to sample only the randomly selected sites. The NOAA sites will be sampled by a NOAA project that will be conducted during the same period. These data will be shared and used in the analyses of both programs.

Allocation of sites among treatment categories is shown in Table 1. Distribution of sites is shown in Figure 1.

2. Physico-chemical Characteristics - Sediment

Bulk sediment samples will be collected at all sites for analysis of particle grain size (PGS), total organic carbon (TOC), and total Kjeldahl nitrogen (TKN). These sediment samples will be collected at points immediately adjacent to three randomly selected sampling locations for the

infaunal samples. To allow examination of stratification in PGS, samples will be collected from the surface (approximately 2 cm deep), 5 and 10 cm below the surface. In addition, a single composite sample for analysis of the organics will be collected from the surface at the three sampling sites. All samples will be preserved by freezing.

Table 1
Allocation of Sampling Sites Between Geographic and Spill Exposure Strata in this Study

Geographic Strata	Oiled and Washed	Oiled & Unwashed
Northern Insular	16 sites 15 previously sampled sites + Northwest Bay West Arm (sampled by NOAA)	4 sites 3 previously sampled random sites + Bay of Isles (sampled by NOAA)
Southern Insular	7 sites 5 random sites + Shelter and Sleepy Bays (sampled by NOAA)	13 random sites
Total Sampling Sites	23	17
Number of Historic Sites	3	1
Number or New Random Sites	20	16

PGS distributions will be determined using a pipette method (Plumb 1981) modified to correct for dissolved solids (*i.e.*, salinity and the dispersant added to keep silt/clay particles from clumping). Percent weights within each phi category will be used to calculate cumulative phi values for 16, 50, and 84 percent of each sample. Five statistics will be determined from these values. These are: median grain size = phi_{50}; median grain size in mm = $2exp(-phi_{50})$; mean grain size in phi; mean grain size in mm; and sorting coefficient = $(phi_{84} - phi_{16})/2$.

In the laboratory, the samples used for analysis of organic nutrients in the sediments will be purged of inorganic carbon, dried at 70°C, ground, and sieved through a 120-mesh screen. TOC will be measured using EPA method 9060A. TKN will be measured by a titrametric method as described in EPA Method 351.3. Quality control (QC) for TOC will include analysis of standards, method blanks, and comparison of replicate analyses. QC for TKN will include analyses of spiked blanks and replicate analyses of spiked samples.

3. Physico-chemical Characteristics – Seawater Characteristics

A YSI Model Handheld SCT meter will be used to measure temperature and salinity at each site sampled by the biological teams.

4. Organization of Coarse-grained Clasts (Armoring)

Armored beaches probably represent a late stage in a progressive process in which coarser clasts on a "gravel" beach become organized. Methods for quantifying the degree of organization,

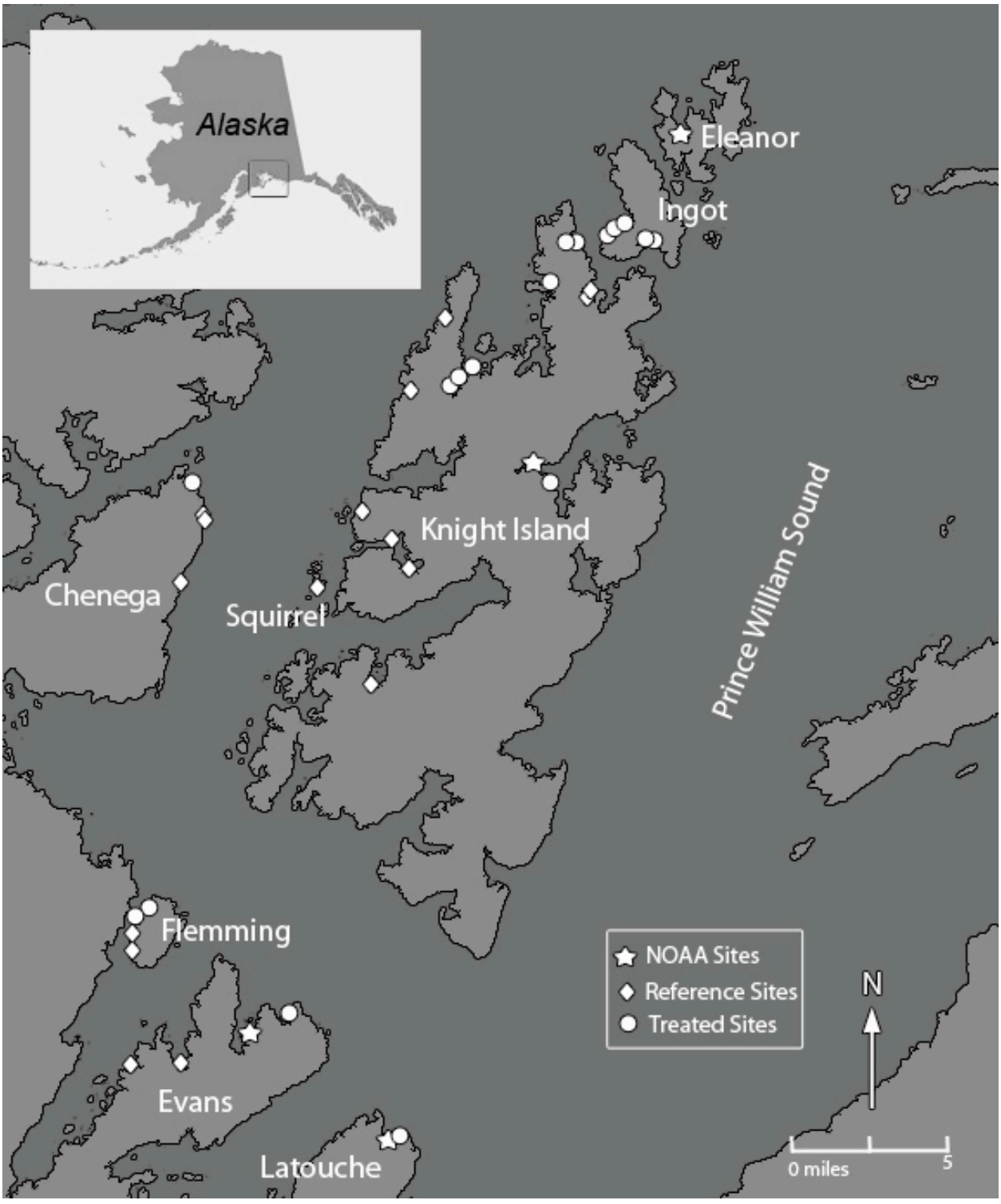

Figure 1. Proposed bivalve sampling sites in western Prince William Sound, Alaska. These sites were sampled in the 2002 study (Lees and Driskell 2007). The NOAA sites (indicated by stars) will be sampled by NOAA as part of a concurrent sampling program.

from completely random or disorganized to well imbricated, have not been described in the field in the marine environment. However, quantification of armoring along mixed coarse sediment beaches of Prince William Sound is central to determining the effect of clast organization on the success rate of clam assemblages. As a first-order approximation, comparison of grain-size distributions from surface and sub-surface samples can be used to determine the degree of armoring (Ferguson 2003). While a variety of field (Bluck 1967; Isla 1993), laboratory (Parker and Klingeman 1982; Gomez 1993; Gomez 1994; Aberle and Nikora 2006) and combination (Church *et al.* 1998; Nikora *et al.* 1998) studies have attempted to classify the degree of clast armoring in both coarse-grained beaches and mountainous streams, at present, no widely accepted metric exists to describe the degree of armoring or the effect of armoring on the substrate's shear strength. Only Gomez (1994) attempts to quantify shear stress of an armored surface in the laboratory; his metric is based on the nominal diameter and mean grain sizes of variously shaped gravel clasts. No similar studies have been conducted in the field. As such, a multifaceted approach is proposed to determine the relative degree of substrate armoring encountered at these study sites.

The proposed methods are morphometric in their approach; that is, the proposed methodology seeks to quantify the degree of coarse-clast organization by comparing the relative dimensional attributes of the clasts (sizes, shapes, *etc.*), porosity, and hypsometry of the gravel beach at each study site. Sediments will be examined in detail both *in situ* in the field and in subsamples collected and analyzed in greater detail in the laboratory.

Sediment organization sampling will be undertaken at eighteen study locations selected to provide equal representation of Washed and Unwashed sites and a gradient of exposures in each category. At each site, a square plywood frame of known interior area (<1 m^2) will be placed randomly on the beach surface. The region of sediment inside the frame will be tagged with spray paint and the frame subsequently removed. A detailed *in situ* analysis of those tagged clasts will be initiated with the collection of photos using a pre-calibrated digital camera purchased from EOS Systems Inc. These images will later be used in conjunction with Eos Systems PhotoModeler Scanner© software package to create three-dimensional models of the beach surface (see below).

A series of physical field measurements will supplement digital images and provide further characterization of the clast distributions. A "base level" for the tagged surface will be determined as mean surface of the highest two-thirds of clasts in the study plot. All tagged clasts will then successively be removed from the plot. The three primary axes of each clast will be measured and each clast will be described in terms of roundness and sphericity. Once all clasts have been removed, the depth from "base level" to the underlying surface will be measured. Finally, a shallow trench will be dug adjacent to the study plot to allow the detailed stratigraphy to be recorded.

When viable and deemed useful (*i.e.*, when a sufficiently large portion of sand- to silt-sized particles exists in the substrate), sediment samples will be collected from study plots and returned to the lab for further analyses. Grain size analysis will be accomplished by means of dry sieving at ½ phi intervals down to 4 phi (0.0625 mm; very fine sand / silt boundary) and a Laser Diffraction Particle Size Analyzer (LDPSA) will be used to delineate sediment fractions to

11 phi (0.00049 mm; fine clay). These analyses will provide statistics for the determination of mean, median, sorting (graphic standard deviation), skewness (asymmetry of the probability) and kurtosis (peakedness of the probability distribution) of the sediment. These statistics provide a reliable means of comparing the grain-size distributions between study sites. Finally, water displacement studies will be used to derive a basic measurement of the porosity of the sediment sample.

Digital images collected in the field will be post-processed using the Eos Systems PhotoModeler Scanner© software package. This method applies a dense surface modeling (DSM) algorithm that allows the program to compute the three-dimensional location of a surface point corresponding to the image patch. A DSM of the study plot surface will be created, providing for three-dimensional analysis of the surficial, armoring layer or clasts. Once exported to GIS software, these data can be used to obtain depth slices through the sediment layer. Basic Matlab-based image analysis can then be employed to determine the ratio of total area of the clasts in the image (A_c) to total area of the plot (A_t); from this, a hypsometric curve for the plot will be produced.

5. Biological Sampling

In the NOAA studies cited above and the 2002 study, we used a clam-gun core to sample infauna and the associated bivalves. It became clear when we analyzed these samples during the 1990-96 NOAA studies that this approach provided good information on smaller clam species and juveniles of larger clam species but did not provide adequate data on abundance and size structure of the naturally less abundant, older, larger size clams. This shortcoming created an important gap in our understanding of the long-term dynamics of clam populations and recovery. Consequently, for the 2002 study, we chose to use two contrasting methods to gain a fuller understanding of population and recovery dynamics. Smaller bivalves again will be sampled using core samplers 10.7 cm in diameter (0.009 m^2) by 15 cm deep, replicating the methods used in the NOAA study. Five cores (total of 0.045 m^2 sampled) will be collected at randomly selected locations along a 30-m transect laid parallel to the water line at each site at the lowest feasible level for completing the sampling and within the specified elevation range (-0.6 to 0.8 m [-2.1 to +2.6 feet] relative to MLLW); the actual level will vary with differing tide stage. Each sample will be field-sieved through a 1.0-mm mesh screen, washed into a double-labeled Ziploc bag, and fixed with buffered 10% formalin-seawater solution. These samples will be collected to provide data consistent with and comparable to the 2002 program and to gain an understanding of the status of smaller clam species and younger size classes of the larger, more longevous clams.

For the larger, older, less abundant and typically more dispersed bivalves, sediments inside a square 0.0625-m^2 quadrat will be excavated to a depth of 15 cm using a shovel and hands. Three replicate excavations (a total of 0.1875 m^2 sampled) will be collected adjacent to first, third, and fifth randomly placed core samples described above. These sediments will be sieved through 6.35-mm (0.25-inch) mesh hardware cloth on site, the bivalves removed, placed in labeled bags, and frozen for shipment to the laboratory. These samples, providing useful information on abundance and size- and age-structure of older size classes, will be collected to gain an

understanding of the status of the larger, more longevous clams. They will also be used to assess biomass at the various sites.

The two sample types provide complementary data. The core data provide information on a wider spectrum of sizes but, because larger animals are generally rare, these data are better suited for evaluation of the smaller clams and juveniles of the larger species. This component is lost in the sieving process for the excavation samples but, because that approach samples four times the surface area, it provides substantially better information on the larger, less abundant clams. Processing the excavation samples with the finer mesh sieve used for the core samples would require an inordinate amount of time both in the field and in the lab.

Following receipt in the laboratory, the core samples will be washed on a 1-mm sieve to remove the formalin-seawater solution and then preserved in 70% isopropyl alcohol. Core and excavation samples will be washed one at a time to remove sediment, debris, and preservative, where applicable, and then sorted to separate them from inorganic and organic materials in the sample. The clams will then be identified and counted. After identification and enumeration, shell length will be measured with digital calipers to 0.1-mm precision. In addition, age will be estimated for the two major hardshell species (*Leukoma* and *Saxidomus*) by counting growth checks (annuli). Subseqently, whole and tissue weights will be measured for a subsample spanning the full range of shell lengths for each species. Arbitrary size criteria based on examination of the size-frequency histograms for each species will be used to distinguish juveniles from adults for one set of analyses. In the case of the 2002 study, *Leukoma* specimens with shell lengths <10 mm were classified as juvenile and the criterion for *Saxidomus* was <12 mm.

C. Data Analysis and Statistical Methods

Three types of statistical analyses will be used in this study, namely, a descriptive metric for shoreline exposure, inferential statistics, and exploratory analyses. The shoreline exposure metric scores exposure to wave action and currents for each site, based on geological and biological conditions at the site as recorded in field notes and site photos. The inferential statistics will measure the significance of differences between the oiled-but-unwashed reference sites and Treated sites for specific summary values or indices (*e.g.*, species richness or density of an indicator bivalve species). Exploratory analyses will include some appropriate combinations of multivariate analyses.

1. Descriptive Statistics - Shoreline Exposure Metric

During the analytical phase of the 2002 study, we developed a metric that integrates a variety of exposure-related physical and biological factors to provide an index of wave or current exposure (Lees and Driskell 2007). Using our site photos and field notes to assess the various criteria, we devised an ordinal evaluation of twelve site conditions that reflect the degree of exposure. The factors include seven physical characteristics of the beach (shape and weathering of individual rocks, degree of imbrication, shingling, or armoring of the rock "population", presence of silt on coarser sediments or rocks, and the susceptibility of the site to current or wave action), and five biological characteristics (absence or level of development of epibenthic algae, animals, or an

amorphous biological "turf" on the rocks, presence of eelgrass offshore of the site or burrowing organisms within the sediments). Each feature was scored on a scale of 1 to 5, with low scores assigned to features representing low exposure and high scores representing high exposure. We then averaged factor scores for each site to provide an integrated exposure score for each site. By this method, low exposure scores indicate protected sites whereas high scores indicate exposed sites. Each site was scored without knowledge of its treatment classification in order to avoid biasing the score. The exposure scores were then paired with the appropriate environmental or biological variables for each site to evaluate the importance of exposure in any observed patterns or in differences in patterns observed between Treated and Unwashed sites.

For this study, we will utilize the specific site exposure scores that were calculated for the 2002 study.

2. Metrics for Organization of Coarse-grained Sediments

Organization of coarse-grained sediments at selected sites will be compared based on all parameters described above for field and laboratory methods evaluating coarse-grained sediments. A relative "armoring index" will be devised based on a combination of various parameters, including the A_c/A_t ratios, hypsometric curves, porosity, and grain size distribution statistics. These indices will further be compared to the patterns observed for the bivalve assemblage to determine the relative importance of each index in regard to the degree of armoring and population recovery.

3. Inferential Statistics

Most of the inferential statistics will be either two-sample or paired t-tests. Where we don't have sufficient information to predict an impact, we will use two-tailed tests. Typically, we prefer to use randomization or permutation statistics (Edington 1987; Manly 1997) in contrast to the classical parametric techniques. These distribution-free computer-intensive methods do not impose the assumptions of equality of variance or normal distribution of data specified by parametric techniques. They rely solely on a truly random sample and the empirical distribution of the data to calculate the exact significance of the statistic. Comparisons between the unwashed and treated arrays for biological and sediment variables will be evaluated primarily with one-way randomization t-tests run using an Excel add-in, Resampling Stats (Blank *et al.* 2001) or Student's t-test (Sokal and Rohlf 1969).

While acknowledging the inherent dangers of multi-comparison testing (*i.e.*, the likelihood of finding some positive results based solely on probability rather than a real effect; also termed losing control of the alpha error), we will be looking for overall trends of significant effects (weight-of-evidence) and supporting evidence from the exploratory analyses rather than relying on any "critical" inferential decision result. Thus, Bonferroni corrections to experiment-wise alpha will not be used.

Correlations between variate pairs within the unwashed and treated categories will be analyzed using one of two methods to gain an understanding of the manner in which the variables relate to one another both within and between treatment categories. In some cases, regression equations

describing the relationships and the significance of the relationship will be calculated using either the Pearson product-moment method (Sokal and Rohlf 1969). Where possible, however, the exact significance of the correlations will be calculated using Resampling Stats to develop a specific distribution curve for correlation coefficients (r) for each resampled data set (Blank *et al.* 2001). With the latter method, the calculated value of r for a relationship will be compared against the possible distribution of r from repeated reshuffling of the data for each variate (5000 iterations) to determine the exact probability that the observed value of r could occur.

4. Exploratory and Multivariate Analyses

Exploratory analyses might be as simple as graphically looking at various stratum- or species-specific histograms for the bivalve species or as complex as a full-blown clustering and ordination exercises using multi-species biological and physical data (Clarke 1993). This form of analysis can be quite useful for discerning and interpreting common or correlated patterns in the data that are difficult to quantify with probability values. However, exploratory analyses are invaluable for providing the understanding of natural processes that is sufficient to interpret the inferential findings and to formulate testable hypotheses. For multivariate analyses, we will use clustering and ordination using multi-dimensional scaling. These analyses will be run using PRIMER (Clarke and Warwick 2001).

5. Summary Statistics

The species-site matrix will be summarized numerically in terms of the species richness (S), number of individuals (N), and the Shannon-Wiener information species diversity index (H'). This diversity index accentuates the effects of rare species on the species richness aspects of species diversity (Krebs 1998). The software package, EstimateS, will be used to calculate the index (Colwell 2005).

TOC and TKN data will be used to calculate C/N ratios for each of the sampling locations. This ratio is useful in assessing the type of organics that predominates at a location, *i.e.*, whether the organics at a site are more influenced by benthic diatoms or bacteria or fresh or weathered detrital material or hydrocarbons. C/N ratios of less than 10 are typical of bacteria and rapidly dividing diatoms (Tyson 1995; Valiela 1995). C/N ratios for fresh benthic algae or seagrass typically range from 12 to 20. Fresh terrestrial plant matter has C/N values between 20 and 30. Finally, petroleum hydrocarbons have very high C/N ratios (James R. Payne, pers. comm.) because they are carbon-rich and nitrogen-poor. As all of these materials age, their C/N ratios increase, *i.e.*, they have less nitrogen per unit of carbon (Tyson 1995).

6. Outlier Analysis

In a conservative approach, four methods recommended by EPA (1992) for identifying outliers will be employed to identify outliers. These included a z-score method, a modified z-score method using the median and median of absolute deviation, the boxplot method, and the Grubbs (1969) T value. Values identified as outliers will be omitted from further statistical analyses.

A. Description of Study Area

Prince William Sound is a relatively protected fjord system located on the southcentral coast of Alaska. The shoreline is heavily dissected and irregular, providing a high diversity of shoreline types and a wide range of exposures (Figure 1). We conducted the 2002 study in western and southwestern portions of Prince William Sound that were in the path of the oil slick as it flowed through the sound. Areas where sites were selected include: islands in the Knight Island archipelago (*i.e.*, Eleanor (60.3844° N, 147.75°W), Ingot, Disk, Knight, and Squirrel Islands), as well as Chenega, Evans (60.0996°N, 148.047°W), Flemming, and Latouche Islands (60.0653°N, 147.838°W). To maximize the potential for finding lingering effects after 13 years, we focused on areas that were moderately to heavily oiled and subsequently exposed to shoreline treatment involving high-pressure hot- or warm-water washing (Treated sites) as well as heavily or moderately oiled sites that were not washed (Unwashed sites). We further concentrated our efforts on beaches in protected embayments and small coves primarily composed of a heterogeneous mixture of cobbles, pebbles, sand, and silt (*i.e.*, mixed-soft habitats). However, we also sampled in relatively more exposed beaches such as Sleepy Bay and Disk Island. Unwashed sites were randomly selected and were interspersed throughout the sampling area.

The semi-diurnal tides have an extreme tidal excursion of about 5.5 m. We propose to sample the beaches between 0.6 meter (2.1 ft) below Mean Lower Low Water (MLLW = 0 meter) and 0.8 m (2.6 ft) above MLLW.

E. Coordination and Collaboration with Other Efforts

We have coordinated our sampling effort with Mr. Gary Shigenaka (NOAA Emergency Response Division) in order to eliminate duplicate sampling at the historic NOAA sites and to expand the geographic scope of his investigation following up on his 2007 findings that abundance of hardshell clams (especially littlenecks) appeared to be dwindling.

We will coordinate with village leaders in Chenega, Cordova, and Tatitlek to arrange providing 1-hour presentations of the findings of our 2002 study and the objective of the proposed study. Our intent is to make these presentations at the annual Alaska Marine Sciences Symposium (January 2010) and in the villages during the field effort (August 2010).

III. SCHEDULE

A. Project Milestones

The objectives for this program are listed below. Estimated times of fulfillment are listed for each objective.

Objective 1. Evaluate whether the depressed condition of bivalve assemblages at Treated sites observed in our earlier studies continues to be general at Treated sites throughout western Prince William Sound.
To be met by 30 June 2011

Objective 2. Develop metrics for "armoring".
To be met by 31 March 2011

Objective 3. Evaluate if the hypothesized role of "armoring" continues to be valid.
To be met by 30 June 2011

Objective 4. Add a third point to the recovery trajectory, thus increasing the accuracy of recovery predictions.
To be met by 15 July 2011

Objective 5. Re-assess the validity of the hypothesis that differences in three sediment characteristics between Treated and Unwashed sites do not play in the apparent depression of bivalve assemblages in washed sediments.
To be met by 30 June 2011

Objective 6. Assess the accuracy of the hypothesis that hardshell clams are suffering recruitment failure in Prince William Sound based on a paired comparison of abundance at sites sampled in 2002 and in this study.
To be met by 15 July 2011

Objective 7. Provide presentations to the communities of Chenega, Cordova, and Tatitlek on the results of the 2002 study of clam recovery and the purpose and objectives of the proposed study at the 2010 Alaska Marine Sciences Symposium and during the field effort.
To be met in the 2nd and 4th quarters, FY10

B. Measurable Project Tasks

FY10, 1st quarter (1 October 2009 – 31 December 2009)
October 2009: Project funding approved by Trustee Council.
October - November 2009: Arrange and finalize contracts with subcontractors
20 December 2009: Submit quarterly report

FY10, 2nd quarter (1 January 2010 – 31 March 2010)
No Project Activity
25 March 2010: Submit quarterly report

FY10, 3rd quarter (1 April 2010 – 30 June 2010)
20 June 2010: Complete clam recovery and sediment organization field sampling programs.
25 June 2010: Ship bivalve and sediment samples to respective labs for analysis.
26 June 2010: Submit quarterly report

FY10, 4th quarter (1 July 2010 – 30 September 2010)
July – September: Analysis of bivalve and sediment samples and commence photogrammetric analysis of sediment photographs.
25 September 2010: Submit quarterly report

FY11, 1st quarter (1 October 2010 – 31 December 2010)
October – December: Analysis of bivalve and sediment samples and photogrammetric data.

20 December 2010: Submit quarterly report.

FY11, 2nd quarter (1 January 2011 – 31 March 2011)

1 March 2011: Complete sediment and clam sample and photogrammetric analyses.
5 March 2011: Commence statistical analysis for bivalve and sediment data and photogrammetric data.
25 March 2011: Submit quarterly report.
31 March 2001: Complete development of "armoring" metrics.

FY11, 3rd quarter (1 April 2011 – 30 June 2011)

1 May 2011: Complete statistical analysis for bivalve and sediment data.
1 May 2011: Commence preparation of draft final report.
25 June 2011: Submit quarterly report.

FY11, 4th quarter (1 July 2011 – 30 September 2011)

1 September 2011: Submit annual report.

FY12, 1st quarter (1 October 2011 – 31 December 2011)

15 October 2011: Complete draft preparation and submit draft final report.
20 December 2011: Submit quarterly report.

FY12, 2nd quarter (1 January 2012 – 31 March 2012)

January (dates not known): Attend Alaska Marine Sciences Symposium and present project results.
15 January 2012: Receive and address peer review comments on draft report.
15 March 2012: Secure final approval, acceptance of final report.
25 March 2012: Submit quarterly report.

FY12, 3rd quarter (1 April 2012 – 30 June 2012)

30 May 2012: Publication of final report complete, delivered to ARLIS.
25 June 2012: Submit quarterly report.

FY12, 4th quarter (1 July 2012– 30 September 2012)

No Project Activity.

IV. LITERATURE CITED

Aberle, J., and V. Nikora. 2006. Statistical properties of armored gravel bed surfaces. Water Resources Res. 42, W11414, doi 10.1029/2005WR004674.

Blank, S., C. Seiter, and P. Bruce. 2001. Resampling Stats in Excel, Version 2. Resampling Stats, Inc, Arlington, Virginia. 172 pp.

Bluck, B. J. 1967. Sedimentation of beach gravels: examples from South Wales. J Sed. Petrol. 37: 128-156.

Church, M., M. A. Hassan, and J. F. Wolcott. 1998. Stabilizing self-organized structures in gravel-bed stream channels: Field and experimental observations. Water Resources Res. 34(11): 3169-3179.

Clarke, K. R., 1993. Non-parametric multivariate analyses of changes in community structure. Australian Journal of Ecology 18:117-143.

Clarke, K. R., and R. M. Warwick. 2001. Change in marine communities: an approach to statistical analysis and interpretation. Plymouth, PRIMER-E.

Colwell, R. K. 2005. EstimateS: Statistical estimation of species richness and shared species from samples. University of Connecticut, USA. Persistent URL, <purl.oclc.org/estimates>.

Edgington, E. S. 1987. Randomization Tests. Statistics: textbooks and monographs, v. 77, 2nd Ed. Marcel Dekker, New York, New York.

EPA. 1992. Framework for Ecological Risk Assessment. Risk Assessment Forum. U.S. Environmental Protection Agency. Washington, D.C.

Ferguson. R. 2003. *Armor.* In: Encyclopedia of Sediments and Sedimentary Rocks, Middleton, G. V., Church, M. J., and Coniglio, M., eds. New York: Springer. pp. 21-22.

Gomez, B. 1993. Roughness of stable, armored gravel beds. Water Resources Res. 29: 3631-3642.

Gomez, B. 1994. Effects of particle shape and mobility on stable armor development. Water Resources Res. 30(7): 2229-2239.

Grubbs, F. E. 1969. Procedures for detecting outlying observations in samples. Technometrics 11: 1-21.

Houghton, J. P., R. Gilmour, D. C. Lees, W. B. Driskell and S. C. Lindstrom. 1997. Long-term recovery (1989-1996) of Prince William Sound littoral biota following the *Exxon Valdez* oil spill and subsequent shoreline treatment. National Oceanic and Atmospheric Administration, Ocean Assessment Division. December 1997. NOAA Tech Memo NOS ORCA 119. 132 pp, Appendix A – D.

Isla, F. I. 1993. Overpassing and armoring phenomena on gravel beaches. Marine Geology, 110: 369-376.

Krebs, C. J. 1998. Ecological Methodology. 2nd Ed. Addison-Welsey Educational Publishers, Inc., Menlo Park, CA. 620 pp.

Lees, D. C., and W. B. Driskell. 2007. Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches In Prince William Sound. Prepared for National Oceanic & Atmospheric Administration, National Marine Fisheries Service, Office of Oil Spill Damage & Restoration and *Exxon Valdez* Oil Spill Trustee Council. 121 pp.

Manly, B. F. J. 1997. Randomization, Bootstrap and Monte Carlo Methods in Biology. 2nd Ed. Chapman and Hall, London, U.K.

Nikora, V. I., D. G. Goring, and B. J. F. Biggs. 1998. On gravel-bed roughness characterization. Water Resources Res. 34(3): 517-527.

Parker, G., and P. Klingeman. 1982. On why gravel bed streams are paved. Water Resources Res. 18(5): 1409-1423.

Plumb, R. A. H. 1981. Procedures for handling and chemical analysis of sediment and water samples. For U. S. Environmental Protection Agency and US Army Corps of Engineers, Tech. Rep. EPA/CE-81-1.

Shigenaka, G., D. A. Coats, and A. K. Fukuyama. 2008. Population Recovery Status of Littleneck Clams in Prince William Sound: An Unexpected Turn of Events. Draft report prepared for *Exxon Valdez* Oil Spill Restoration Project. 89 pp.

Sokal, R. R., and F. J. Rohlf. 1969. Biometry: The principles and practice of statistics in biological research. W. H. Freeman and Co. San Francisco. 776 pp.

Tyson, R. V. 1995. Sedimentary Organic Matter: Organic facies and palynofacies. Chapman & Hall, London. 615 pp.

Valiela, I. 1995. Marine Ecological Processes. 2nd Edition. Springer-Verlag, New York. 686 pp.

V. CV/Resumes

A. Dennis C. Lees – Principal Investigator, Project Manager

Address: Littoral Ecological & Environmental Services
1075 Urania Ave.
Leucadia, CA 92024
Phone: (760) 635-7998
E-mail: dennislees@cox.net

Education: Ph. C. Marine Ecology, Univ. of California Riverside and San Diego State University, California, 1974
M. Sc. Biology, San Diego State University, 1970
B. S. Zoology, University of California, Santa Barbara, 1961

Scientific Diving qualification:
Basic SCUBA training, Scripps Institution of Oceanography, University of California, 1959
Advanced Diver, NAUI, 1990

Employment Positions:
1997-present President, Littoral Ecological & Environmental Services
1985 – 1996 Manager, Marine Sciences Group, Odgen Environmental & Energy Services
1975 – 1985 Senior Marine Biologist, Dames & Moore, Homer, AK, and Seattle, WA
1971 – 1975 Senior Marine Biologist, Marine Biological Consultants, Costa Mesa, CA

Five Related Publications:

Lees, D. C., and W. B. Driskell. 2007. Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches In Prince William Sound. Prepared for National Oceanic & Atmospheric Administration, National Marine Fisheries Service, Office of Oil Spill Damage & Restoration and *Exxon Valdez* Oil Spill Trustee Council. 121 pp.

Lees, D. C., J. P. Houghton and W. B. Driskell. 1996. Short-term effects of several types of shoreline treatment on rocky intertidal biota in Prince William Sound. 1991 *Exxon Valdez* Oil Spill Symposium. Bethesda, MD, American Fisheries Society Symposium. **18:** 329-348.

Houghton, J. P., **D. C. Lees,** W. B. Driskell, S. C. Lindstrom, and A. J. Mearns. 1996. Recovery of Prince William Sound intertidal epibiota from Exxon Valdez oiling and shoreline treatments, 1989 through 1992. American Fisheries Society Symposium 18:379-411.

Lees, D. C. 1992. What Southern California Can Learn From the *EXXON VALDEZ* Oil Spill Experience. Perspectives on the Marine Environment: Symposium on the Marine Environment of Southern California, Univ. of So. California, Los Angeles, CA, Sea Grant Program, University of Southern California. pp. 105-126.

Lees, D. C., J. P. Houghton, W. B. Driskell, S. Landino, and D. E. Erikson. 1990. Baseline Conditions and Initial Effects in Intertidal and Shallow Subtidal Assemblages in Prince William Sound Following the EXXON Valdez Oil Spill. Final Data Report for EXXON

Company, USA. Dames & Moore Technical Report Series — The EXXON Valdez Oil Spill Studies., Dames & Moore, Seattle, Washington.

Five Other Significant Publications:

Lees, D. C., W. B. Driskell, J. R. Payne, and M. O. Hayes. 2002. Intertidal reconnaissance survey in middle and upper Cook Inlet. Draft Report. Leucadia, CA, Cook Inlet Regional Citizens Advisory Council: 299 pp + Appendices.

Driskell, W. B., J. L. Ruesink, **D. C. Lees**, J. P. Houghton, and S. C. Lindstrom. 2001. Long-term signal of disturbance: *Fucus gardneri* after the Exxon Valdez oil spill. Ecol. Appl. 11(3): 815-827.

Lees, D. C., J. P. Houghton, D. E. Erikson, W. B. Driskell, and D. E. Boettcher. 1980. Ecological studies of intertidal and shallow subtidal habitats in lower Cook Inlet, Alaska. U. S. Dept. of Commerce, NOAA: OCSEAP. Final Reports 44(1986): 437-646.

Lees, D. C., and R. J. Rosenthal. 1977. An ecological assessment of the littoral zone along the outer coast of the Kenai Peninsula for State of Alaska, Department of Fish and Game. Anchorage, AK, Prepared for Alaska Dept. of Fish and Game by Dames & Moore: 101.

Lees, D. C., and G. Carter. 1972. The masking response to surge, sunlight, and ultraviolet light in *Lytechinus anamesus* (Echinoidea. Ecology **53**: 1127-1133.

Collaborators and other affiliations:

Mr. Alan Bennett, Southwest Alaska Network, National Park Service
Mr. Greg Challenger, Polaris Applied Sciences, Inc.
Mr. William B. Driskell, consultant
Mr. James Elliott, consultant
Mr. Darren Fong, Golden Gate National Recreation Area, National Park Service
Ms. Nora Foster, Univ. of Alaska Museum of the North
Dr. Miles O. Hayes, Research Planning, Inc.
Dr. Jonathan P. Houghton, Pentec Environmental/HartCrowser
Dr. Sandra Lindstrom, University of British Columbia
Mr. Gary Mauseth, Polaris Applied Sciences, Inc.
Dr. Jacqui Michel, Research Planning, Inc.
Dr. James R. Payne, Payne Environmental Consultants, Inc.
Dr. Jennifer Ruesink, University of Washington
Ms. Carol Sanders, P.E., SAI Engineering
Ms. Susan Saupe, Cook Inlet Regional Citizens Advisory Council
Dr. Jason Stutes, Pentec Environmental

Alaska Research Experience:

Diving, intertidal, underwater television, seining, and trawling studies in Prince William Sound, Outer Kenai Peninsula, Kachemak Bay, the west side of Cook Inlet, False Pass, Akutan, Dutch Harbor, Bristol Bay, eastern Chukchi Sea, and Prudhoe Bay since June 1975 for NOAA OCSEAP, NOAA HAZMAT, University of Alaska, Fairbanks, Alaska Departments of Fish and Game and Transportation, several oil and mining companies, other consulting firms, local and regional agencies, Cook Inlet and Prince William Sound Regional Citizens Advisory Councils, National Park Service, and the EVOS Trustee Council.

B. Jonathan P. Houghton – Assistant Principal Investigator

Address: Pentec Environmental/Hart Crowser, Inc.
120 Third Ave, So.
Edmonds, WA 98020
Phone: (425) 329-1150
E-mail: jon@pentecenv.com

Education: Ph. D. Marine Biology University of Washington 1973. Dissertation Title: Intertidal Ecology of Kiket Island Washington with Emphasis on Age and Growth of *Protothaca staminea* and *Saxidomus giganteus* (Lamellibranchia: Veneridae)
AB Biology, Harvard University 1964

Employment: Positions:

1989-present Senior Marine Biologist and Principal, Pentec Environmental/Hart Crowser Inc. Edmonds, WA
1973 – 1989 Senior Marine Biologist, Dames & Moore, Seattle, WA
1964 – 1969 Naval Officer, Naval Submarine Service

Five related publications:

Houghton, J. P., D. C. Lees, W. B. Driskell, and S. C. Lindstrom. 1997. Long-term recovery (1989-1996) of Prince William Sound littoral biota following the Exxon Valdez oil spill and subsequent shoreline treatments. NOAA Technical Memorandum NOS ORCA 119, Seattle, WA

Houghton, J. P., J. E. Starkes, M. Chambers, and D. Ormerod. 2005. Marine fish and benthos studies in Knik Arm, Anchorage, Alaska. Report to Kink Arm Bridge and Toll Authority and HDR Alaska, Inc. 12214-10/12214/11 Nov. 30, 2005.

Houghton, J. P., R. H. Gilmour, D. C. Lees, W. B. Driskell, S. C. Lindstrom, and A. J. Mearns. 1997. Prince William Sound intertidal epibiota seven years later: Has it recovered? 1997 International Oil Spill Conference Proceedings pp. 679-686.

Houghton, J. P., D. C. Lees, W. B. Driskell, S. C. Lindstrom, and A. J. Mearns. 1996. Recovery of Prince William Sound intertidal epibiota from Exxon Valdez oiling and shoreline treatments, 1989 through 1992. American Fisheries Society Symposium 18:379-411.

Driskell, W. B., A. K. Fukuyama, **J. P. Houghton**, D. C. Lees, A. J. Mearns, and G. Shigenaka. 1996. Recovery of Prince William Sound intertidal infauna from *Exxon Valdez* oiling and shoreline treatments, 1989 through 1992. American Fisheries Society Symposium 18:362-378.

Five other significant publications:

Houghton, J.P. 1973. Intertidal ecology of Kiket Island, Washington, with emphasis on age and growth of *Protothaca staminea* and *Saxidomus giganteus* (Lamellibranchia: Veneridae). Ph.D. dissertation. University of Washington, Seattle.

Lees, D. C.**, J. P. Houghton** and W. B. Driskell. 1996. Short-term effects of several types of shoreline treatment on rocky intertidal biota in Prince William Sound. 1991 *Exxon Valdez* Oil Spill Symposium. Bethesda, MD, American Fisheries Society Symposium. **18:** 329-348.

Driskell, W. B., J. L. Ruesink, D. C. Lees, **J. P. Houghton**, and S. C. Lindstrom. 2001. Long-term signal of disturbance: *Fucus gardneri* after the Exxon Valdez oil spill. Ecol. Appl. 11(3): 815-827.

Lees, D. C., **J. P. Houghton**, D. E. Erikson, W. B. Driskell, and D. E. Boettcher. 1980. Ecological studies of intertidal and shallow subtidal habitats in lower Cook Inlet, Alaska. U. S. Dept. of Commerce, NOAA: OCSEAP. Final Reports 44(1986): 437-646.

Lindstrom, S.C., **J.P. Houghton**, and D.C. Lees, 1999. Intertidal Macroalgal Community Structure in Southwestern Prince William Sound, Alaska. Botanica Marina, Volume 42, by Walter de Gruyter Press.

Collaborators and other affiliations:

Dr. James Buell, Buell & Associates
Mr. Greg Challenger, Polaris Applied Sciences, Inc.
Mr. William B. Driskell, consultant
Mr. David Erikson, URS Corporation
Mr. Dennis Lees, Littoral Ecological and Environmental Services
Dr. Sandra Lindstrom, University of British Columbia
Mr. Gary Mauseth, Polaris Applied Sciences, Inc.
Dr. Jacqui Michel, Research Planning, Inc.
Dr. Robert Paine, University of Washington (ret.)
Dr. James Reyff, Illingworth Rodkin, Inc
Dr. Jennifer Ruesink, University of Washington
Ms. Susan Saupe, Cook Inlet Regional Citizens Advisory Council
Dr. Jason Stutes, Pentec Environmental

Alaska Research Experience:

33 years of research experience in offshore, coastal, and riverine environments from Prince of Wales, to the Aleutians, and to Prudhoe Bay. Experience has included baseline studies in remote areas, ecological risk assessment, permitting, and habitat restoration. Designed and conducted substantial field research in estuarine and marine environments and has special expertise in the littoral and benthic ecology of Southeast and Southcentral Alaska (Cook Inlet and Prince William Sound). Developed and employed systematic sampling protocols for intertidal habitats in multi year research programs, and used grab, trawl, and video techniques for investigating subtidal assemblages.

C. Dr. Duncan M. FitzGerald – Lead Geomorphologist

Address: Dept. of Earth Sciences
Boston University
675 Commonwealth Ave.
Boston, MA 02215
Phone: 617-353-2530
E-mail: dunc@crsa.bu.edu

Education: Ph.D. Geology, University of South Carolina 1977
M.S. Geological Oceanography, Texas A&M University 1972
B.A. in Geology, University of New Hampshire 1970

Academic Positions:

Boston University

Assistant-Associate-Professor of Earth Sciences	1977- Present
Director of Undergraduate Studies of Earth Sciences	1993-1996
Chairman, Department of Geology	1982-1987
Acting Chairman, Department of Earth Sciences	1981(sum), 1995

Adjunct Positions

Graduate Faculty, Department of Geological Sciences, University of Maine	2001- 2007
Graduate Faculty, Department of Earth and Environmental Sciences, University of New Orleans	2004- Present

Professional Societies and Offices:

Geological Society of America
Society of Economic Paleontologists and Mineralogists
President, Coastal Sedimentary Research Group, 1989-1990
Society of Economic Paleontologists and Mineralogists, Eastern
President 1988/1989
Vice President 1987/1988
International Association of Sedimentologists
International Geological Correlations Programme (IGCP)
Project No. 247: Quaternary Shorelines 1989-1995
National Undersea Research Center, Southeast Coordinator 1987-1989
Editorial Board: Journal of Coastal Research
Associate Editor 1994-Present
Geological Society of America Grants Committee Member 1997-1999
Geological Society of America, NE Section Council Committee Member 1998-2001
Louisiana Gulf Shoreline Restoration Science Advisory Board 2002-2006
Chairman, Science Review Committee, Pontchartrain Restoration Program, Louisiana 2005-2008
Fellow of the Geological Society of America 2006

Five related publications:

FitzGerald, D.M., *Buynevich, I.V., *Fenster, M.S., Kelley, J.T., and Belknap, D.F., 2005, Coarse-grained sediment transport in northern New England Estuaries: A synthesis, *in*: FitzGerald, D.M., and Knight, J. (eds.) *High Resolution Morphodynamics and Sedimentary Evolution of Estuaries*, Springer, New York, p. 195-214.

FitzGerald, D.M., and *Buynevich, I.V., 2001, Coarse-grained sediment contribution to the nearshore and inner shelf by large fluvial estuarine systems, New England, USA, Chapman Conference, Ponce, Puerto Rico, p. 15.

FitzGerald, D.M., *Buynevich, I.V., Fenster, M.S., Kelley, J.T., and Belknap, D.F., 2001, Contribution of coarse-grained sediment to the nearshore and inner shelf by large estuaries: New England, USA. GSA Abstracts with Programs, v. 33.

FitzGerald, D.M., 1996, Geomorphic variability and morphologic and sedimentologic controls on tidal inlets, *Journal of Coastal Research*, Spec Issue #23, p. 47-71.

FitzGerald, D.M., 1988, Shoreline erosional-depositional processes associated with tidal inlets, *in*: Aubrey, D.G., and Weishar, L. (eds.), *Hydrodynamics and Sediment Dynamics of Tidal Inlets*, Springer-Verlag, New York, p. 269-283.

Five other significant publications:

FitzGerald, D.M., and Knight, J., (editors), 2005, *High Resolution Morphodynamics and Sedimentary Evolution of Estuaries*, Springer, New York. 365 p.

Davis, R.A., and FitzGerald, D.M., 2004, *Beaches and Coasts*, Blackwell Science, Oxford, England. 419 p.

FitzGerald, D.M., *Lincoln, J.M., Fink, L.K., and Caldwell, D.W., 1990, Morphodynamics of tidal inlet systems in Maine, in: Marvenney, R. (ed.), *Studies in Maine Geology*, Maine Geol. Survey, v. 5, p. 67-96.

FitzGerald, D.M., Rosen, P.S., and *van Heteren, S., 1994, New England Barriers, *in*: Davis, R.A. (ed.), *Geology of Holocene Barrier Island Systems*, Springer-Verlag, Berlin, Chap. 8, p. 305-394.

FitzGerald, D.M., and Rosen, P.S. (editors), 1987, *Glaciated Coasts*, Academic Press, London, England. 364 p.

Collaborators and other affiliations:

Dr. Miles O. Hayes, Research Planning, Inc.
Dr. Jacqui Michel, Research Planning, Inc.
Dr. Ed Owens, Polaris Applied Sciences, Inc.

VI. Budget Justification

A. Personnel:

Dennis C. Lees will function as Project Manager and Principal Investigator for this project, and is responsible for sampling design, direction and conduct of intertidal surveys, collection of bivalve and sediment samples, identification, measurement, and aging of clams, data entry and analysis, report preparation, project management.

Request:	**FY10:**	**$23,400;** $100/hour, 1.35 months
	FY11:	**$31,600;** $100/hour, 1.82 months
	FY12:	**$15,200;** $100/hour, 0.88 months
	Total:	**$70,200**

B. Travel:

Travel will be llimited to that necessary to transport the sampling crew to Cordova in FY10 and to attendance at the Alaska Marine Sciences Symposium to present the results of the study in FY12.

FY10:
Round trip air travel from San Diego to Cordova, D. Lees & field technician; for field survey
Round trip air travel from Seattle to Cordova, J. Houghton & field technician; for field survey
Round trip air travel from Boston to Cordova, D. FitzGerald & field technician; for field survey
Per diem in Cordova during mobilization & demobilization; 2 days (12 man-days)
Per diem in Cordova during geomorphological armoring study; 5 days (10 man-days)
Cab fare in Cordova during mobilization and demobilization; 4 trips
Vehicle rental in cordova during geolomorphological armoring study; 5 days
Excess baggage and shipping fees for transporting sampling equipment to and from Cordova for air passengers and transporting samples to laboratories.
This travel is necessary to move the sampling personnel, equipment, and sampling supplies to Cordova to access the sampling vessel or floatplane.

FY12
Round trip air travel from San Diego to Anchorage, D. Lees; for Alaska Marine Sciences Symposium.
Per diem in Anchorage during AMSS; 4 days
Cab fare in Anchorage during AMSS; 2 trips
This travel is necessary to enable Mr. Lees to attend the annual Alaska Marine Sciences Symposium and meet with the EVOS staff.

Request:	**FY10:**	**$11,490**
	FY11:	**$ 0**
	FY12:	**$ 2,040**
	Total:	**$8,240**

C. Contractual:

FY10

Dr. Jonathan P. Houghton, benthic consultant, $120/hour, 0.692 months, $14,400 subcontract; assistance in intertidal field surveys.
Benthic Field Assistants (2), $40/hour, 1.30 months total, $9,040 subcontract; assistance in intertidal field surveys.
Dr. Houghton and the field assistants are necessary to field the two field teams needed to visit the specified number of sampling locations and collect the samples needed to address the specified hypotheses.
Dr. Duncan M. FitzGerald, geomorphological consultant, $120/hour, 0.404 months, $14,400 subcontract; performance of geomorphological field surveys.
Geomorphological Field Assistant, $40/hour, 0.404 months total, $3,500 subcontract; assistance in geomorphological field surveys.
Dr. FitzGerald and his field assistant are necessary to field the team needed to develop a metric for armoring and assess armoring at selected beaches.
M/V Auklet, $1,550/day, 0.27 months, $12,400 subcontract; vessel support for intertidal field surveys for clams on west side of Prince William Sound; necessary for efficient collection of the samples required to address the specified hypotheses.
Excavation clam sorting, 60 samples @ $100/sample, $6,000; needed to describe status of larger long-lived clams in sediments.
Core clam sorting, 80 samples @ $200/sample, $16,000; needed to describe status of smaller clams in sediment.
The clams in the excavation and core samples must be identified and their sizes measured in order to address the specified hypotheses.

FY11
Excavation clam sorting, 48 samples @ $100/sample, $4,800; needed to describe status of larger long-lived clams in sediments.
Core clam sorting, 100 samples @ $200/sample, $17,500; needed to describe status of smaller clams in sediment.
The clams in the excavation and core samples must be identified and their sizes measured in order to address the specified hypotheses.
Sediment chemistry analysis (TOC & TKN) - 36 samples of each type @ $140/sample, $5,040.
Sediment grain size analysis - 108 samples @ $ 120/sample, $12,960.
The sediment variables must be analyzed in order to address the specified hypotheses regarding relationships between sediments and bivalves and address geomorphological issues.
Dr. Duncan M. FitzGerald, geomorphological consultant, $120/hour, 0.35 months, $7,200 subcontract; performance of geomorphological and photogrammetric analyses.
Geomorphological Field Assistant, $40/hour, 0.46 months total, $4,000 subcontract; assistance in geomorphological and photogrammetric analyses.
Laser Diffraction Particle Size Analyzer analysis - 15 samples @ $ 100/sample, $1,500.
The geomorphological and photogrammetric analyses must be performed to address the specified hypotheses regarding bivalves and armoring.

FY12
Dr. Jonathan P. Houghton, benthic consultant, $120/hour, 0.231 months, $4,800.

Dr. Duncan M. FitzGerald, geomorphological consultant, $120/hour, 0.231 months, $4,800 subcontract; analysis of geomorphological and photogrammetric data and report preparation.
Geomorphological Field Assistant, $40/hour, 0.231 months total, $2,000 subcontract; assistance with data analysis and report preparation.

Request:	**FY10:**	**$75,915**
	FY11:	**$53,000**
	FY12:	**$11,600**
	Total:	**$140,515**

D. Commodities:
FY10
Sampling supplies, expendable sampling equipment (transect lines, quadrats, field screens, etc.), and expendables, $1,100

FY11
Preservatives (formalin and ethanol), $300
These commodities are necessary for collection, processing, and preservation of the samples.

FY12
Printing expenses for final report, $300

Request:	**FY10:**	**$1,100**
	FY11:	**$ 300**
	FY12:	**$ 300**
	Total:	**$1,700**

E. New Equipment:
FY10
Calibrated digital camera
PhotoModeler Scanner software for photogrammetric analysis of sediment organization photographs and application training

Request:	**FY10:**	**$5,955**

F. Existing Equipment:
Request: **None**
No expenses will be charged for use of existing equipment (*e.g.,* GPS and camera systems).

G. Indirect Fees

Request:	**FY10:**	**$4,723**
	FY11:	**$2,665**
	FY12:	**$ 692**
	Total:	**$8,080**

H. EVOS G&A

Request:	**FY10:**	**$11,032**
	FY11:	**$ 7,881**
	FY12:	**$ 2,676**
	Total:	**$21,589**

VII. Data Management and Quality Assurance/Quality Control (QA/QC) Statement

Several instruments and processes will require QA/QC observations during the laboratory and data analysis of this program.

Sediment Organics: The laboratory conducting the chemical analyses for sediment will employ standard QA/QC procedures. QC for TOC will include analysis of standards, method blanks, and comparison of replicate analyses. QC for TKN will include analyses of spiked blanks and replicate analyses of spiked samples. These data will be included in the lab reports and reviewed following receipt of the data from the laboratory.

Sorting, Identification, and Enumeration: Initially, the materials included in all sorted samples will be retained for a QA check. Subsequently, 10 percent of the samples sorted by each sorter will be re-sorted by another sorter to check whether clams were missed in the initial sort. If the re-sort finds, in any re-sorted sample, that more than 10 percent of the clams in the original sample were missed, all retained samples will be re-sorted.

Clams in the sorted samples will be identified and enumerated by taxon. Ten percent of these samples will be re-examined to assess the accuracy of the identifications and counts. If any clam identifications are found to be incorrect, all samples will be re-evaluated. If counts are more than 10 percent in error in any sample, all will be recounted. Specimens of each species will be sent to a recognized bivalve taxonomist to verify the species identity and to assure the name used is up-to-date.

Size Measurements: Shell length of the clams in each sample will be measured with electronic digital calipers. This instrument will be calibrated to zero at the beginning of each measurement session and the agreement between the digital display and an actual metric scale on the beam of the instrument will be checked. Shell length will be remeasured for 10 percent of the samples. If average length differs by more than 5 percent in any sample, all samples will be remeasured.

Data Summaries: All data transferred from field notes or other written records will be double-checked for accuracy, if possible by a person different from the original transcriber. In spreadsheet summaries containing numerical measurements (counts or size measurements), calculations involving summation or multiplication will be cross-checked by computing the grand sums or averages on the basis of orthogonal sums or averages. If the sums or averages are not identical, the summation or averaging equations will be rechecked for accuracy.

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

Budget Category:	Proposed FY 10	Proposed FY 11	Proposed FY 12	Proposed FY 13	TOTAL PROPOSED
Personnel	$23.4	$31.6	$15.2	$0.0	$70.2
Travel	$11.5	$0.0	$2.0	$0.0	$13.5
Contractual	$75.9	$53.0	$11.6	$0.0	$140.5
Commodities	$1.1	$0.3	$0.3	$0.0	$1.7
Equipment	$6.0	$0.0	$0.0	$0.0	$6.0
Indirect *(will vary by proposer)*	$ 4.7	$ 2.7	$ 0.7		$8.1
SUBTOTAL	$122.6	$87.6	$29.9	$0.0	$240.0
General Administration (9% of subtotal)	$11.0	$7.9	$2.7	$0.0	$21.6
PROJECT TOTAL	$133.6	$95.4	$32.6	$0.0	$261.6
Other Resources (Cost Share Funds)	$0.0	$0.0	$0.0	$0.0	$0.0

COMMENTS: In this box, identify non-EVOS funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

FY10 - 13

Project Title: Re-Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound

FORM 4A
NON-TRUSTEE AGENCY SUMMARY

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Name	Project Title					
Dennis C. Lees	Lead Principal Investigator		1.35	17.3		23.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.35	17.3	0.0	
					Personnel Total	$23.4

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Round-trip airfare from San Diego to Cordova	1.0	2			2.0
Round-trip airfare from Seattle to Cordova	0.7	2			1.4
Round-trip airfare from Boston to Cordova	1.0	2			2.0
					0.0
Per Diem in Cordova			22	0.2	4.5
Vehicle rental in Cordova			5	0.1	0.5
Cab fare in Cordova			4	0.0	0.1
Shipment of equipment , supplies, and samples			1	1.0	1.0
					0.0
					0.0
					0.0
				Travel Total	$11.5

FY10

Project Title: Re-Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound

FORM 4B PERSONNEL & TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

Contractual Costs: Description	Contract Sum
Vessel Charter - 8 days at $1650/day	12.4
Jonathan P. Houghton - Assistant Principal Investigator - 0.692 months @ $120/hour	14.4
Benthic Field Assistants - 1.304 months @ $40/hour	9.0
Excavation clam sample sorting - 60 samples @$100/sample	6.0
Core clam sample sorting - 80 samples @$175/sample	14.0
Floatplane charges - 5 days at ≈$1635/day	8.2
Duncan M. FitzGerald - Geomorphology Principal Investigator - 0.404 months @ $120/hour	8.4
Geomorphological Field Assistant - 0.404 months @ $40/hour	3.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$75.9

Commodities Costs: Description	Commodities Sum
Sampling supplies, expendable equipment, and expendables	1.1
Commodities Total	$1.1

FY10

Project Title: Re-Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
Eos PhotoModeler Scanner photogrammetric software & accessories	1.0	3.2	3.2
Callibrated digital camera	1.0	1.8	1.8
Training program for PhotoModeler	1.0	1.0	1.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$6.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
None		

FY10

Project Title: Re-Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound

FORM 4B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

Personnel Costs:		GS/Range/	Months	Monthly		Personnel
Name	Project Title	Step	Budgeted	Costs	Overtime	Sum
Dennis C. Lees	Lead Principal Investigator		1.8	17.3		31.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.8	17.3	0.0	
					Personnel Total	$31.6

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY11

Project Title: Re-Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound

FORM 4B PERSONNEL & TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

Contractual Costs: Description	Contract Sum
Sediment chemistry analysis (TOC & TKN) - 36 samples of each type @ $140 /sample	5.0
Sediment grain size analysis - 108 samples @ $ 120/sample	13.0
Excavation clam sample sorting - 48 samples @$100/sample	4.8
Core clam sample sorting - 100 samples @$200/sample	17.5
Duncan M. FitzGerald - Geomorphology Principal Investigator - 0.346 months @ $120/hour	7.2
Geomorphological Field Assistant - 0.461 months @ $40/hour	4.0
Laser Defraction Particle Size Analysis - 15 samples at $100/sample	1.5
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$53.0

Commodities Costs: Description	Commodities Sum
Sorting materials, supplies, and preservatives (ethanol)	0.3
Commodities Total	$0.3

FY11

Project Title: Re-Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
None		

FY11

Project Title: Re-Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound

FORM 4B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Personnel Sum
Name	Project Title					
Dennis C. Lees	Lead Principal Investigator		0.9	17.3		15.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.9	17.3	0.0	
					Personnel Total	$15.2

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Travel Sum
Round-trip airfare from San Diego to Anchorage	1.0	1			1.0
Per Diem in Anchorage			4	0.3	1.0
Cab fare in Anchorage			2	0.0	0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.0

FY12

Project Title: Re-Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound

FORM 4B PERSONNEL & TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

Contractual Costs: Description	Contract Sum
Jonathan P. Houghton - Assistant Principal Investigator - 0.231 months @ $120/hour	4.8
Duncan M. FitzGerald - Geomorphology Principal Investigator - 0.231 months @ $120/hour	4.8
Geomorphological Field Assistant - 0.231 months @ $40/hour	2.0
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$11.6

Commodities Costs: Description	Commodities Sum
Printing	0.3
Commodities Total	$0.3

FY12

Project Title: Re-Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound

FORM 4B CONTRACTUAL & COMMODITIES DETAIL

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
DETAILED BUDGET FORM FY 10- FY 12

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
None		

FY12

Project Title: Re-Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound

FORM 4B
EQUIPMENT DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

Personnel Costs:		GS/Range/	Months	Monthly		Personnel
Name	Project Title	Step	Budgeted	Costs	Overtime	Sum
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.0	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Travel
Description	Price	Trips	Days	Per Diem	Sum
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY13

Project Title:
Lead PI:

FORM 4B
PERSONNEL &
TRAVEL DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

Contractual Costs: Description	Contract Sum
If a component of the project will be performed under contract, the 4A and 4B forms are required. **Contractual Total**	$0.0

Commodities Costs: Description	Commodities Sum
Commodities Total	$0.0

FY13

Project Title:
Lead PI:

FORM 4B
CONTRACTUAL & COMMODITIES DETAIL

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
DETAILED BUDGET FORM FY 10- FY 12

New Equipment Purchases: Description	Number of Units	Unit Price	Equipment Sum
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY13

Project Title:
Lead PI:

FORM 4B
EQUIPMENT DETAIL